ENERGY FOR SOUTH ASIA

UPDATE ON THE COSTS / CONCLUSIONS CONTAINED IN THE FEASIBILITY REPORT ON VIABILITY OF POWER EXPORTS FROM BANGLADESH TO INDIA

January 2005

Prepared by

Nexant

Contract No. 386-C-00-03-00135-00

Prepared for

USAID SARI/Energy Program

www.sari-energy.org

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List Of Abbreviation

ABT	Availability Base Tariff
AC	Alternating Current
BD	Bangladesh
BPDB	Bangladesh Power Development Board
BTU	British Thermal Unit
CEA	Central Electricity Authority
DG	Diesel Generator
DVC	Damodar Valley Corporation
E/NER	Eastern/Northeastern Region
ER	Eastern Region
EVH	Extra High Voltage
GOB	Government of Bangladesh
GOI	Government of India
GT	Gas Turbine
GTCC	Gas Turbine Combined Cycle
GW	Gigawatt
HEP	Hydro Electric Project
HV	High Voltage
HVDC	High Voltage Direct Current
Hz	Hertz
Kms	Kilometers
KV	Kilo Volt
Kwh	Kilo Watt Hour
MVA	Mega Volt Ampere
MW	Megawatt
MWH	Megawatt Hour
NA	Not Available
NEEPCO	North Eastern Electric Power Corporation
NER	North Eastern Region
NR	Northern Region
NTPC	National Thermal Power Corporation
PGCB	Power Grid Company of Bangladesh
PGCIL	Power Grid Corporation of India Limited
PLF	Plant Load Factor
ST	Station
TK	Taka
USAID	United States Agency for International Development

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Executive Summary

Background

This desk study provides update on the USAID sponsored study to validate the viability of power exports from Bangladesh to India. It aims at strengthening the knowledge base to support SARI/Energy program aiming at establishment of beneficial electricity energy linkages between India and Bangladesh. This study leads to the following conclusions:

- Power exports from Bangladesh to India continue to be techno-economically viable at price levels worked out in the report on "Viability of Power exports from Bangladesh to India" in September 2000.

- Distinct technical possibility exists of interconnecting Bangladesh grid with Eastern grid of India to economically transmit power exports to India. Expensive HVDC link is not required now, as the frequencies problems in India have already been addressed through the introduction of Availability Based Tariff .

- Interconnections and extensions of 33KV and 11KV lines all along the India and Bangladesh border should be studied and explored for the mutual economic benefits on both sides of the border.

- Attempts be made to improve the plant load factor of existing generation capacity in Bangladesh for economically promoting exports to India.

- Exchange of power between India and Bangladesh on both sides is a distinct feasibility.

- The proposed separation of 2x375 MW combined cycle gas turbine plant, one 375 MW unit dedicated to India and other 375 MW unit to Bangladesh will no more be required if the Eastern/Northeastern grids in India and Bangladesh grid are interconnected at 220KV

Conclusions

The study broadly leads to the following conclusions duly validating the findings of the pre-feasibility report on the viability of Power Exports from Bangladesh to India.

- The Eastern and Northeastern Regions of India forming the border between Bangladesh and India are surplus in power generation both in meeting peak demand and energy requirements and are likely to continue in that situation till 2012 or later.

- The other three regions in India i.e. Northern, Western and Southern would continue to be in power deficit both in meeting peak demand and energy requirements upto 2012.

- Eastern, Northeastern and Western grids in India have been interconnected and are operational at the same frequency (2004).

- Power export from Bangladesh to India would be best suited, by transferring it through Eastern region to nearest points in Northern region.

- Distinct technical feasibility exists of interconnecting Bangladesh grid with E/NE Region grid in India at 220KV/132KV to operate them at same frequency.

- Power export from Bangladesh to India is expected to be techno-economically viable at gas price of $1.5 to $1.85 (at the well head); high efficiency gas based combined cycle GT plant (overall efficiency 56-57) and transmission costs upto delivery point in the range of $10 to $15 per MWH.

- Interconnections and extensions of 33KV and 11 KV lines all along the India Bangladesh border are considered a viable option for small power exchanges to the mutual benefit on both the sides.

- Possibility exists of import of economical power from India into Bangladesh in appropriate locations and speedy economic growth of Bangladesh.

- Special efforts need to be made in Bangladesh to improve the plant load factor of its existing generation capacity to promote small-scale power exports to India.

Next Steps

- Conduct studies along India–Bangladesh border to identify distribution sub-stations for interconnections and/or extending the 33KV/11KV lines on two sides of the border, to make small exchanges of power possible for mutual benefit of both the sides.

- Study the power export possibilities from Bangladesh to load centers in Northern region in India, at the nearest locations, to economize on transmission costs in the context of implementation of the Electricity Act-2003 in India.

- Identify generation plants in Bangladesh and Eastern/Northeastern region of India for cost effective exports to load centers on the other side, as well as to ensure stable operation of the integrated grid.

- Develop commercial framework to make the foregoing feasible, and arrange for exchange of power between India and Bangladesh at small scales at 33KV/11KV as well as at grid level.

Section 1 Background and Approach

SARI/Energy program aims at facilitating establishment of beneficial energy linkages among the participating countries comprising India, Nepal, Bhutan, Maldives, Sri Lanka and Bangladesh. Two pre-feasibility studies to assess the possibilities of interconnecting the transmission grids of India-Nepal-Bhutan-Bangladesh and India-Sri Lanka were carried out during the Phase-I of the program. A pre-feasibility study on the viability of Power Exports from Bangladesh to India was also carried out under USAID funding and completed in September 2000.

The pre-feasibility study on the viability of power exports from Bangladesh to India is based on the investment in an efficient, gas fired gas turbine combined cycle plant in two modules of 375MW each. One module would export through Eastern Regional grid of India to Northern Grid of India in a most likely scenario, and the other module would supply power within Bangladesh. Power exports are expected to be implemented using private investments and delivered price of power exports to India are seen competitive against future new generating sources in India.

In addition to looking at these macro level opportunities to interconnect the transmission grids of the participating countries, which would take time to materialize, there exist opportunities to harness the benefits of cooperation in energy sector by extending 11KV, 33KV line from the electric Sub-stations in the vicinity of India-Bangladesh border (4100 kilometers), on both sides of the border as done in the case of India-Nepal and India-Bhutan borders. Extending the sub-transmission network from the sub-stations along the India-Bangladesh border would provide an attractive option of exchange small amounts of power between the two countries. Large-scale exchanges of small power at multiple points would require sub-transmission grid and investments on both sides of the borders.

Section 2 Purpose and Scope of the study

The main purpose of this desk study is to update the costs/conclusions in the feasibility report on 'Viability of Power Exports from Bangladesh to India' with a view to establish the feasibility of power export from Bangladesh to India. Further appreciating that it may still take some time to implement Grid interconnections between India, Nepal, Bangladesh and Bhutan, this study shall identify potential sites/sub-stations for trading small quantities of power along India- Bangladesh border with a view to benefit both sides of the border as happens along India – Nepal border. This study report covers the following:

- Study the report on 'Viability of Power Exports from Bangladesh to India (September 2000)', and update the data, assumptions, costs used to establish the feasibility of power exports from Bangladesh to India.

- Study of the current (2004) grid systems of Bangladesh and India bordering Indian States of West Bengal, Assam, Meghalaya, Tripura and Mizoram to identify sub-stations close to India-Bangladesh border.

- Assessment of the approximate distance between identified sub-stations and the border from the two sides at voltage levels 220KV, 132 KV and below

- Study of the patterns of load demand, supply and tariffs on the two sides given the available information, and assess the approximate quantity of power that might technically be traded between such close sub-stations on two sides of the border.

- Based on the techno-commercial aspect, comment on the feasibilities of trading and exchange of power between India and Bangladesh within the limitations of ground realities.

Section 3 Update on the study -Viability of Power Exports from Bangladesh to India

The report of the study sponsored by USAID and completed by Bechtel National Inc. was prepared to assist the Government of Bangladesh in evaluating the validity of entering into an agreement with the private sector to build a combined cycle GT gas fired plant in the range of 500-1000MW to export portion of its output to India. The pre-feasibility analysis reached following major conclusions:

- Exports up-to 400MW of power via the Eastern Region Grid in India to the Northern Region Grid are feasible.
- The potential sites at Bheramara and Siragganj in the western region of Bangladesh appear to be preferable due to their favorable cost advantage (lower transmission costs)
- The estimated delivered price would be competitive against future new generating sources for India. Estimates of delivered tariff range from $0.044 to $0.047/kwh.
- Power exports would support a minimum gas price of $1.5 to 1.85/mm BTU (at the well head)
- Gross foreign revenues to Bangladesh from power exports are estimated to be $120 million to $ 130 million per annum.

3.1 Changes in Demand Pattern in India

The Indian Market is segmented into five regions. All India demand at peak has gone up to about 90,000Mw in March 2004 (up from 70,000MW in 2000) with energy consumption of 520 million MWHs. The Eastern and North Eastern regions are synchronized with Western region also interconnected to it recently. The MW demands have increased in each Region, to 25GW (from 21GW) in NR, to 27GW (from 24GW) in Western region, to 24GW (from 19GW) in Southern region, and 14 GW (from 8GW) in Eastern and North Eastern region.

3.2 Status of interconnections and Export from E/NER within India

According to Eastern Regional Electricity Board officials, in the recent months (April–July 2004) Eastern Region is exporting substantially to other Regions. Exports in the range of 600 to 700MW are taking place to Northern Region through 500MW Back to back HDVC and radial supplies. The exports to Western Region have increased to about 1000-12000Mw through Grid interconnections. Exports to Southern region are in the range of 500-600MW through 500MW Back to back HVDC. Thus interregional transfer capability in the Indian grid system has substantially increased. The earlier plans to connect Eastern grid with Northern grid by the two HVDC connections by 2001 and 2003 respectively have been slightly modified. One HVDC interconnection has already been commissioned. The plan of the second HVDC interconnection has been dropped, and instead additional links at 400kv

and 765kv are being planned along with the new generation capacity of NTPC in the Eastern region. These links are likely to be operational by 2006-07.

3.3 Export potential from IPP project in Bangladesh to India

The report zeroed in at potential sites for 750MW GTCC plant for the power export project, at Bheramara or Sirajganj in the Western region of Bangladesh. The Indian side interconnection for this export is stated to be at Bharampur in West Bengal (to be connected to) 60kms away Bheramara, where the 230kv grid sub-station exists in Bangladesh. The technical feasibility of such an interconnection continues to exist taking into account the power transfer capability of interconnections from Eastern Region of India to Western Region and Northern Region of India. The aspect, which needs detailed examination, is that further interconnections from Bharampur in India should facilitate evacuation of Bangladesh power to India at nearest load centers in Northern region of India. It would need system studies of the interconnected grid along with Bangladesh grid in the steady state situation of connected generating stations in Bangladesh and East and Northeastern grids of India.

3.4 Comparative installation costs in Bangladesh and India

The installed capital cost of 2x375MW combined cycle GT plant was estimated at US$338 million equivalent to approximately Rs1555 crores. This is very competitive pricing compared to Indian Project installation cost of about Rs 2.6 cr/MW (against Rs 2.1 Cr/MW in Bangladesh) currently being planned by Central Electricity Authority.

3.5 Tariff for power exports from Bangladesh to India

The wholesale tariffs for sale from Bangladesh to Northern grid in India had been estimated in the report, to be in the range of $50 to $60/MWH assuming that projects at high end of generation costs would not be developed in near future. A recent estimate made in India (CEA), on coalmines head thermal stations and combined cycle GT plants indicate that range of future thermal power generation costs in India include coal and GTCC based plants range between $30 to $45.MWH. Adding the transmission costs of $10 to $15/MWH the total bulk supply tariff would range between $40 to $60/MWH. This scenario indicates that delivered tariff between $44/MWH to $47/MWH from Bangladesh to India could still be considered reasonable as the power could be sold to 2 selected Distribution Companies after the unbundling of State Electricity Boards in India. The point to be considered for power exports from Bangladesh to India is that the delivery of power from Bangladesh to a distribution company in India or a bulk consumer in India should be made at the nearest location in Northern region to save transmission costs.

3.6 Commercial/technical feasibility of interconnecting Bangladeshi & Indian grids

Another change in the Indian power system, which has taken place since September 2000, is that Availability Based Tariff has been implemented in all the Regional systems. The ABT penalizes unscheduled interchange of power and the tariff charged for unscheduled interchange of power becomes higher for purchaser and lower for the supplier with reference to normal sale prices. This has helped in maintaining much better frequency regimes in India. In the ER, NER and WR, which are presently interconnected, the frequency variations now

experienced are in the range of 49.5 to 50.2Hz. This has improved the possibility of interconnecting Indian ER grid with Bangladesh at 220KV. The costly HVDC back-to-back interconnection, which could have been required, may not be required now for export of power from Bangladesh to India, as the Availability Based Tariff has helped India address the frequency related issues. However, Bangladesh may have to follow the Availability Based Tariff system for supply of power to Indian grid.

3.7 Interconnections to be at EVH/HV levels

The export of power from Bangladesh to India would be feasible and valid to earn foreign exchange. The gas based 750MW combined cycle GT plant proposed to be set up for power export need not be split into two modules of 375MW each, one catering to the supplies to Bangladesh and other to India. The grid in the ER of India is now operating at 49.5 to 50.2 Hz and it could be technically feasible to interconnect the two grids, if agreed from both sides, at more than one interconnection. Apart from the interconnection between Bahrampur (India) to Bheramera (Bangladesh), another interconnection between Malda (India) and Palashbari or Rangpur in Bangladesh could also be considered, as this has been found feasible as the studies carried out in CEA, India. Interconnection between the two grids could pave the way for many more interconnections at distribution substations at 33KV and 11 KV levels to facilitate small exchanges of power all along the India Bangladesh border, to the mutual benefit of both the sides. Bangladesh could also benefit by import of power from the Indian side in the Western and Northern region of Bangladesh because costs of generation in this part is much higher due to the high cost of fuel oil based generation.

3.8 Capacity Utilization in Bangladesh

In Bangladesh during the FY 2002-03, 450MW AES Meghnaghat combined cycle new power plant was commissioned in the private sector. Maximum generation increased from 3218MW in the previous year to 3428MW in 2002-03. The overall plant load factor (PLF) of the installed capacity of 4680MW in Bangladesh was in the range of **42%-45%** against about **65%** for conventional coal based plus gas turbine power plants in India. This indicates a distinct possibility of improving the capacity utilization factor of Bangladesh generation plants based on gas and thus increasing its capacity to export power to India.

Section 4 Potential for Power Exchange between India and Bangladesh

4.1 Power Generation Facilities in India's Northeast

Bangladesh is surrounded by West-Bengal in India on the west, Meghalaya and Assam on the north and Tripura and Mizoram on the eastern side. The major generation company dedicated to the North i.e. North Eastern Electricity Power Corporation operates in seven states on the Northeast i.e., Assam, Meghalaya, Arunachal Pradesh, Manipur, Nagaland, Mizoram and Tripura. Recently NEEPCO has signed a loan agreement with Power Finance Corporation (India) to set up 600 MW Kameng HEP in Arunachal Pradesh and 280 MW Tripura Gas Based combined cycle project. NEEPCO claims to provide a levelized tariff of Rs 1.50/kwh from these two projects likely to be completed before March 2012.

4.2 Power Exports from Eastern grid to Northern grid within India

In India the power consumption is much higher than Bangladesh and both the peak and energy deficits exist in three major regions. As reported in newspapers in Calcutta (August 2004), Bengal, Jharkhand, Orissa, Bihar and Sikkim together (all in the Eastern Region) sold more than 4000Gwhs in April-June 2004, combining exports from Northeastern region, to other three electricity regions of India. The exports from Eastern/Northeastern region to other regions of Indian in the same period of 2003, was 2600Gwh. On an annual basis, more than 15000Gwhs were exported from Eastern Grid to North, West and South during FY 2003-04 against about 9400Gwhs exported in the previous year, representing a jump of around **60%**. Thus, at **75%** plant load factor the surplus capacity in Eastern/Northeastern region of India is estimated to have increased from about 1400MW in 2002-03 to 2250MW in 2003-04, if the effect of transmission constraints in actual export of power, which might take place from ER/NER, is neglected.

4.2.1 Possibilities of Power Exchange between Bangladesh and India

The total generation in Bangladesh was of the order of 18,400Gwhs in 2002-03 which corresponds to available capacity for generation of the order of 2800MW (feasible) at **75%** PLF. The Bangladesh grid is smaller as compared to the smallest ER/NER Grid of India. Further, range of unit sizes connected to the Bangladesh grid is also smaller as compared to Eastern region. Compared to Northeastern region Bangladesh has similar sizes of units. From the foregoing, it can be concluded that it is feasible to export power from India to Bangladesh and also from Bangladesh to India. On the flip side, the export from India to Bangladesh could be at smaller transmission distances compared to that from Bangladesh to India because adjoining regions i.e., ER/NER in India are surplus in power. In this scenario, low tension, grid interconnections at multiple points, if accepted politically, could be made quite attractive by developing acceptable commercial and technical frame work by mutual consultations on both sides. Selective interconnections based on generating plant location and load centers could reduce the transmission distances from Bangladesh to India.

The map given below (Figure 5.1) gives the location of the power generation facilities and the Substations located in the close proximity of the India-Bangladesh border:

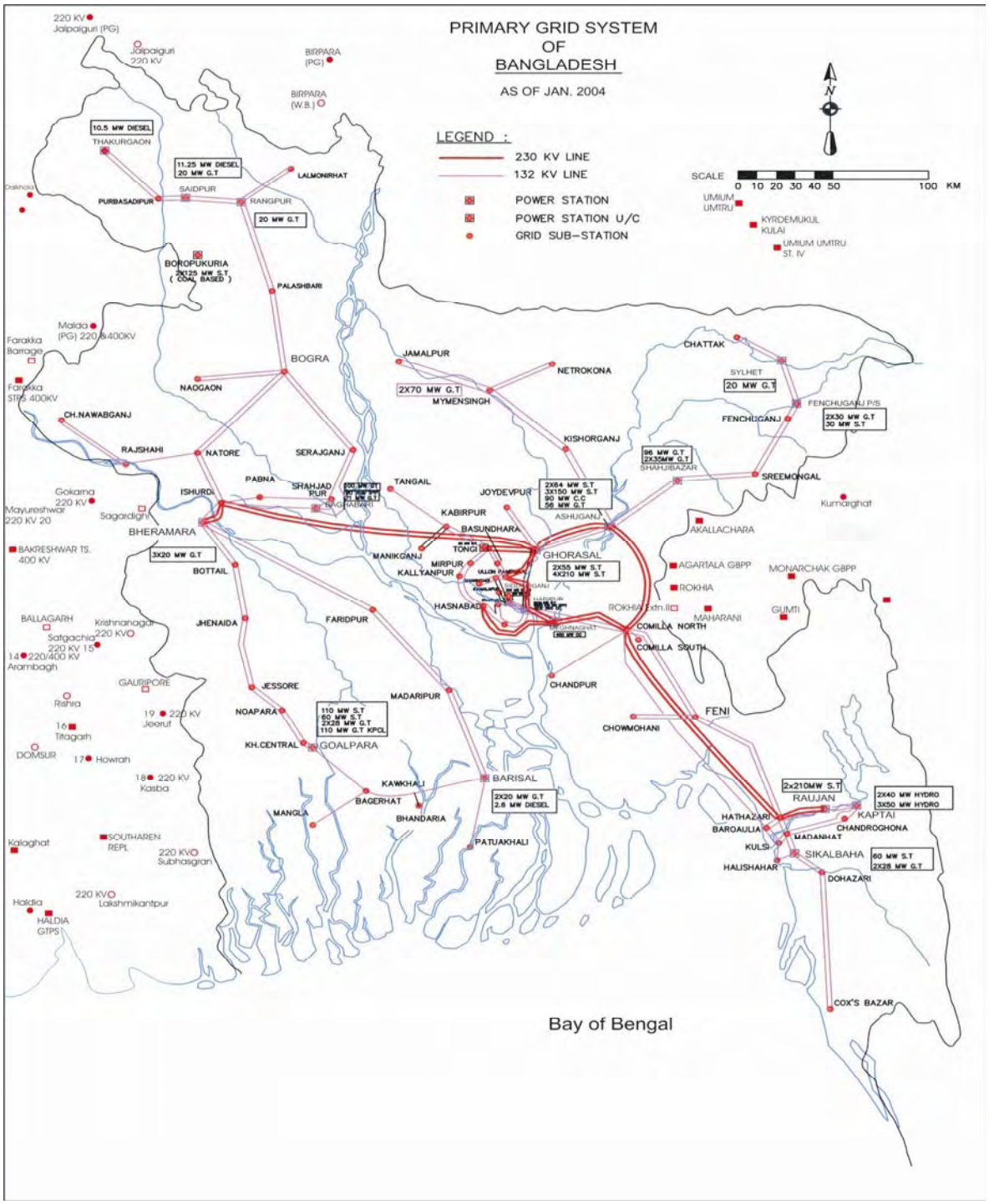

Figure 5.1 Map Showing Power Plants and Substations close to India-Bangladesh Border

5.1 Power Generation Facilities in Bangladesh along India-Bangladesh Border

Bangladesh is surrounded by West Bengal in India on the west, Assam and Meghalaya towards the north and Tripura and Mizoram on the East. The generation facilities with their capacities in Bangladesh along these borders is indicated in the Table 5.1 given below:

Table 5.1 Location of Power Generation Facilities in Bangladesh along India-Bangladesh Border

S.No	Location	Capacity	Approximate distance in Kms
	Near Mizoram Borders	**716 MW**	**30 – 70 Kms**
1	Kaptai Hydro Electric	180 MW	
2	Raujan Steam Turbine	420 MW	
3	Sikal Baha ST	60 MW	
4	Sikal Bawa GT	56 MW	
	Near Tripura Borders	**890 MW**	**30 – 50 Kms**
5	Shahjibazar GT	96 MW	
6	Shajibazar GT	70 MW	
7	Ashuganj ST	128 MW	
8	Ashuganj ST	450 MW	
9	Ashuganj combined cycle	90 MW	
10	Ashuanj GT	56 MW	
	Near Assam borders	**90 MW**	**50 – 60 Kms**
11	Fenchuganj GT	60 MW	
12	Fenchuganj ST	30 MW	
	Near West Bengal borders	**70.5 MW**	**30 – 50 Kms**
13	Bheramara GT	60 MW	
14	Thakurgaon Diesel	10.5 MW	

Source: Plan documents of power utilities in Bangladesh

5.2 Power Generation Facilities in India along India-Bangladesh Border

The generation facilities with their capacities on the Indian side near the Bangladesh border are given in Table 5.2 below:

Table 5.2 Location Power Generation Facilities in India along India-Bangladesh Border

S.No	Location	Capacity	Approximate distance in Kms
	West Bengal	**2000 MW**	**20 – 30 Kms**
1	Farakka thermal Station ST	2000 MW	
	Assam	**240 MW**	**60 – 70 Kms**
2	Bongaigaon ST	240 MW	
	Tripura	**116 MW**	**10 – 20 Kms**
3	Rokhia GT	32 MW	
4	Agartal GT	84 MW	

Source: Central Electricity Authority of India

Section 6 List of Substations Located very near to the Border

There are a number of Grid Substations at 220-230/132 KV levels on both side of the border. Some of these substations are so close that they could be interconnected at a very nominal cost and within a very brief time span to facilitate power exchange/trading. There are some cities/town, such as Agartala, Rokhia, Farraka etc. on the Indian side of the border, located on the border itself or extremely close to it. These existing substations supplying power in their own territory could serve the neighboring towns in Bangladesh as well. The names of some of such substation, their approximate distances from the nearest substation on the other side of the border and the estimated cost for construction of transmission interconnections are given in Table-6.1 below:

Table-6.1 List of Substations Located very near to the Border

Name of Sub-Station on Bangladesh Side	Name of Sub-Station on Indian Side	Approximate Distance	Approx. Cost INR Million
230/132 KV			
Hathazari (3*150 MVA)	NA		
Comilla (N) (3*75 MVA)	Rokhia	30	60
Ashuganj (2* 150 MVA)	Agartala	50	100
Ishurdi (9 * 75 MVA)	Gokarna	100	200
132/33 KV s/s			
Hathazari (2*63MVA)/Chandroghona	NA		
Dohazari (2*40 MVA)	NA		
Cox's Bazar (2*40 MVA)	NA		
Comilla (N) (1*40 MVA)	Rokhia Trip.	30	36
Comilla (S) (4*41 MVA)	Rokhia Trip.(Assam)	30	36
Fenchuganj (2*20 MVA)	Badarpur 132	80	96
Chattak (2*20 + 1*41 MVA)	Cherrapunji 132	50	60
Ahsuganj (3*25 +1*41 MVA)	Tripura Agartala	50	60
Jessore (1*80 + 2*40 MVA)	Tripura Jeerut	60	72
Ishurdi(2*20 + 2*16 MVA)	Gokarna	100	120
Rajshahi (2*30 + 1*20 MVA)	Gokarna 130	50	60
Nawabganj (3*20MVA)	Gokarna Malda 230	60	72
Purbasadipur (1*16 + 2*20 MVA)	Dalkhola 230	80	96
Thakurgaon (2*41 + 1*20 MVA)	Dalkhola 230	60	72

6.1 The list of these Substations in Bangladesh in the vicinity of the India-Bangladesh border:

A comprehensive list of Substations in Bangladesh in the vicinity of the India-Bangladesh border are given in Table 6.2 below:

Table-6.2 List of Grid Substations in Bangladesh along the Indian-Bangladesh Border

Name of Grid Sub-Station	Approx. Distance form Border	Indian State at Border
230/132 KV		
Hathazari (3*150 MVA)	70	Mizoram
Comilla (N) (3*75 MVA)	20	Tripura
Ashuganj (2* 150 MVA)	30	Tripura
Ishurdi (9 * 75 MVA)	40	West Bengal
132/33 KV s/s		
Hathazari (2*63MVA)	70	Mizoram
Dohazari (2*40 MVA)	60	Mizoram
Cox's Bazar (2*40 MVA)	60	Mizoram
Comilla (N) (1*40 MVA)	20	Tripura
Comilla (S) (4*41 MVA)	20	Tripura
Fenchuganj (2*20 MVA)	30	Tripura
Chattak (2*20 + 1*41 MVA)	20	Meghalaya
Ahsuganj (3*25 +1*41 MVA)	30	Tripura
Jessore (1*80 + 2*40 MVA)	25	West Bengal
Ishurdi(2*20 + 2*16 MVA)	40	West Bengal
Rajshahi (2*30 + 1*20 MVA)	10	West Bengal
Nawabganj (3*20MVA)	15	West Bengal
Purbasadipur (1*16 + 2*20 MVA)	30	West Bengal
Thakurgaon (2*41 + 1*20 MVA)	30	West Bengal

Source: Compiled by the author based on the available documentation from Power Utilities in both countries

6.2 List of Grid Substations in India along the Indian-Bangladesh Border:

The comprehensive list of substations on the Indian side in the vicinity of the India-Bangladesh border are given below in Table 6.3:

Table-6.3 List of Grid Substations in India along the Indian-Bangladesh Border

Name of Grid Sub-station	Approx. Distance form border	Indian State at Border
220/132 KV		
Dalkhola	10	West Bengal
Malda	10	West Bengal
Farakka (400 KV)	20	West Bengal
Gokarna	55	West Bengal
Krishnanagar	20	West Bengal
Satgachia	40	West Bengal
Jeerut	20	West Bengal
Kasba	30	West Bengal
Subhasgram	20	West Bengal
Lakshmikantpur	60	West Bengal
Jalpaiguri	20	West Bengal
Birpara	30	West Bengal
Badarpur	60	Assam
132/33 KV s/s		
Tura	30	Meghalaya
Shillong	30	Meghalaya
Cherrapunji	10	Meghalaya
Khliehriat	40	Meghalaya
Kumarghat	30	Tripura
Khowai	10	Tripura
Kamalpur	10	Tripura
Kailashahar	5	Tripura
Agartala	10	Tripura
Aizawal	60	Mizoram
W. Phailang	30	Mizoram
Marpara	10	Mizoram
Tlabung	10	Mizoram

Source: Central Electricity Authority of India: - Distance estimated by author

It is evident from the approximations made of the distance between the border and the location of generating stations and grid sub-stations that large number of points exist along the India-Bangladesh border where distance of interconnections between the two sides may be well within 20 to 60 kms. It is worth noting that there are 21 grid substations combining both sides at 230/132 KV levels where distance from the border is less than 20kms. If further studies are undertaken of the location of 33/11 KV substations along the border it is most likely that there would be many more distribution sub-stations closer to boundaries and closer to each other onthe two sides of the border at 33 KV and 11 KV levels making it feasible for exchange of power between India and Bangladesh on the same pattern as it exists between India and Nepal.

According to Abul Barkat, capacity addition of 1000 MW would be required in Bangladesh to manage the demand in next three years. The annual loss suffered by the industrial sector in Bangladesh as a result of power outages is about Tk 59 billion in production plus value addition. Considering that Indian North East and Eastern region is surplus in power generation; both in thermal and hydro-generation; significant quantity of the deficits could be managed by multiple low cost interconnections between 132 KV and 33 KV voltage levels.

At present only 3.41 million rural households out of a total of 19.1 million households in Bangladesh have electricity connections. Across the border interconnections would help the electricity reach villages and remote areas by extending sub-transmission system from the border sub-stations of India to Bangladesh and vice-versa. Perhaps the approach of extending distribution network of one country to the bordering areas of the other could be considered to help develop rural and remote areas on both sides of the border. The extension of distribution grid from one country to the other may permit access to new areas on both the sides without the necessity of grid interconnection. Grid interconnections at 230 KV or 132 KV levels on two sides would permit larger power flows and would integrate the two Grid systems to bring them to same frequencies. The extended sub-transmission connections at 33 KV and 11 KV levels from Indian side of the border to Bangladesh and vice versa would be technically simpler but would be some what difficult to handle politically.

- Conduct studies along India – Bangladesh border to identify distribution sub-stations for interconnections and/or extending the lines 132KV/11KV on two sides of the border, to make small exchanges of power feasible for mutual benefit of both the sides.

- After the implementation of the EA-2003 in India, study the power export possibilities from Bangladesh to NR in India at the nearest locations to economize on transmission costs.

- Identify generation plants in Bangladesh and E/NE Region of India for cost effective exports to load centers on the other side.

- Develop commercial framework to made it feasible and arrange for exchange of power between India and Bangladesh at small scales at 33/11KV as well as at large scales at 220KV/132KV.

Section 9 Power Sector Scenarios of India and Bangladesh

9.1 Power Scenario in Bangladesh

The four major players in power sector operations and management in Bangladesh are:

- Bangladesh Power development Board – Established in 1972, they own and operate major generation capacity except for the IPPs. Out of the total installed capacity of 4710 MW; 3420 MW is owned by BPDB. They also supply electricity to 16,90,451 consumers (June 2003).

- Power Grid Company of Bangladesh is the National Transmission Company and has been given possession of all transmission assets by BPDB by December 2002. They are wheelers of electricity to transmit bulk power for power stations to load centers.

- Dhaka Electricity Supply authority and Dhaka Electricity Supply Company are involved in Urban Power Distribution. The West Zone Power Distribution Company was created recently by breaking part of BPDBs operations in the Khulna Division.

- Rural Electrification Board was set up in 1977 with the responsibility of executing the rural electrification program in Bangladesh and for taking measures for effective use of electrical power for development of the rural economy. It decentralizes the operation and Management of power distribution by forming cooperatives called Palli Bidyut Samity (PBS) each covering 1000 to 1500 square kms. Member consumers of the cooperatives are responsible for PBSs financial and management functions.

Power System in Bangladesh is integrated into a National Grid with 230 KV and 132 KV transmission systems and East-West Interlinking at 230 KV. It has 3859 kms of 230/132 KV lines and another 2546 kms is planned to be added up to 2012. Out of total installed generation capacity of 4710 MW in Bangladesh; 3986 MW (**84.6%**) is gas based; 494 MW (**10.5%**) is liquid fuel based and 230 MW (**4.9%**) is Hydro based. In west only Baghabari Thermal Station (261 MW) is running on gas; the rest 494 MW Capacity are running on liquid fuel. Total cost per kwh sold is Taka 2.52/kwh in 2003, which is equivalent to Rs 1.96/kwh (Rs 1 = Taka 1.28)

Overall fuel cost per kwh generated in 2002-03 is Tk 2.31/kwh in the west BD against Tk 0.787 in the East BD. This is due to cost of Tk 7.57/kwh on fuel in GTs based on Diesel and Tk 4.99/kwh on fuel in DG sets burning diesel oil (source-Annual report of BPDB – 2002-03).

9.2 Power Scenario in India

In India, the Power Sector is much bigger and much more complex. It is organized on the following lines:

- Total installed capacity in India is of the order of 1,10,000 MW with annual generation of about 5,20,000 Gwh in 2003-04. Installed capacity of over 66,000 MW is coal based (thermal), 29,000MW is hydroelectric and the balance is GT/DG/combined cycle, wind farm and nuclear based. Hydro generation is spread throughout India but major resources are in the North and Northeast. The National level generation companies i.e. National Thermal Power Corporation and National Hydropower Corporation are mainly in Thermal and hydropower Generation respectively.

- Power Grid Corporation of India Ltd. is the national transmission utility. The Transmission Grid in India is at 765KV, 400KV, 220KV and 132KV.

- There are twenty-seven (27) states each having part of their own generation capacities, Transmission networks and Distribution System. Electricity in most of the states was earlier managed by State Electricity Boards, which have now been unbundled in many states with the formation of separate Generation, Transmission and Distribution companies have been set up.

- North East Electric Power Corporation is the generation company owned by GOI dedicated to North Eastern region and owns both Hydro and gas based thermal stations.

- Apart from this Damodar Valley Corporation is a generating organization situated in Eastern Region and operating for development of a geographical region between Bihar and West Bengal. It also owns substantial generating capacity in Hydro and coal based thermal.

- Nuclear Power Corporation also contributes to a small way to the total installed capacity.

Power System in India has developed in five distinct regions i.e., Northern, Western, Southern, Eastern and North Eastern. Till recently regional grids were operating independently at different frequencies. By the end of 2003-04 Eastern, Northeastern region (ER/NER) and Western Grids have been interconnected at AC – 400KV and 220KV interconnections and these are operating at same frequency. The deficits in Southern and Northern regions are much larger. As per Central Electricity Authority (CEA), the National Coordinator for power systems in India the deficits during peak demand by the end of March 2007 are estimated at 5800MW in the Northern Region, 4900MW in the Western Region and 5760MW in the Southern Region. Energy deficits in these regions are also likely to be substantial i.e., to the tune of 30,000 to 38,000GWhs in each region.

Section 10 Conclusions and Next Steps

This report has been prepared based on existing written information, power maps and verbal information collected during discussions with concerned organizations on the Indian side. The study broadly leads to the following conclusions duly validating the findings of the prefeasibility report on the viability of power exports from Bangladesh to India.

- The Eastern and Northeastern Regions of India forming the border between Bangladesh and India are surplus in power generation both in meeting peak demand and energy requirements and are likely to continue in that situation till 2012 or later.

- The other three regions in India i.e. Northern, Western and Southern would continue to be in power deficit both in meeting peak demand and energy requirements upto 2012.

- Eastern, Northeastern and Western grids in India have been interconnected and are operational at the same frequency (2004).

- Power export from Bangladesh to India would be best suited, by transferring it through Eastern region to nearest points in Northern region.

- Distinct technical feasibility exists of interconnecting Bangladesh grid with E/NE Region grid in India at 220KV/132KV to operate them at same frequency.

- Power export from Bangladesh to India is expected to be techno-economically viable at gas price of $1.5 to $1.85 (at the well head); high efficiency gas based combined cycle GT plant (overall efficiency 56-57) and transmission costs upto delivery point in the range of $10 to $15 per MWH.

- Interconnections and extensions of 33KV and 11 KV lines all along the India Bangladesh border are considered a viable option for small power exchanges to the mutual benefit on both the sides.

- Possibility exists of import of economical power from India into Bangladesh in appropriate locations and speedy economic growth of Bangladesh.

- Special efforts need to be made in Bangladesh to improve the plant load factor of its existing generation capacity to promote small-scale power exports to India.